"Express Mail" mailing label number: EL130693348US
Date of Deposit: October 22, 1998

Our Case No. 5050/296

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:		)		
	Ted Christopher	)		
		)	Examiner:	F. Jaworski
Serial No.:	08/746,360	)		
		)	Group Art Unit:	3305
Filed:	November 8, 1996	)		
		)		
For:	Finite Amplitude Distortion-Based Inhomogeneous Pulse Echo Ultrasonic Imaging	)		

#21

FAXED COPY RECEIVED
OCT 26 1998
GROUP 3300

SECOND PROTEST UNDER 37 CFR § 1.291 (a)[1]

Assistant Commissioner for Patents
Washington, D.C. 20231

ATTENTION: DIRECTOR OF GROUP 3300

Sir:

Since the filing of the August 13, 1998 protest, Acuson Corporation ("Acuson") has become aware of European Patent Application EP 0 851 241 A2 ("the Averkiou EPO application"). The Averkiou EPO application claims priority to U.S. Provisional Patent Application Serial Number 60/032,771 ("the Averkiou provisional application") and contains a citation to a 1994 dissertation of one of the inventors, Michalakis Averkiou. Copies of each of these references are enclosed. The filing date (November 26, 1996) of the Averkiou provisional application is later than the filing date (November 8, 1996) of the above-identified patent application ("the Christopher application").

[1] The 1997 amendment to 37 C.F.R. § 1.291(c) removed the blanket limitation of one protest per protestor and provided for a second or subsequent submission in the form of additional prior art. Acuson's August 13, 1998 protest was as complete as possible when filed. Since the filing of that protest, Acuson has become aware of the materials discussed herein.

On October 22, 1998, Acuson filed a protest ("the Averkiou protest") against any pending U.S. patent applications that claim priority to the Averkiou provisional application. Copies of the Averkiou protest and references filed therewith are enclosed. As discussed in the Averkiou protest, the Christopher application may claim the same invention as a pending U.S. patent application that claims priority to the Averkiou provisional application, as shown by the following comparison of Claims 1 and 10 in the Christopher PCT application with Claims 11 and 6, respectively, in the Averkiou EPO application. Appendix A of this protest contains a comparison of other similar claims.

The Christopher PCT Application	The Averkiou EPO Application
1. A method of imaging a sample comprising the steps of:	11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:
generating an ultrasonic signal; directing the ultrasonic signal into a sample, wherein the sample reflects the signal;	transmitting ultrasonic energy into the body at a fundamental frequency;
receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;	receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and
forming an image from one of said higher order component signals of the received distorted signal, including the step of removing from the received distorted signal the first order component thereof; and	processing said harmonic echo signals to produce ultrasonic image display signals; and
displaying said formed image.	displaying said ultrasonic image display signals.
10. A system according to Claim 9, wherein the means for removing the first order component from the received distorted signal includes a high-pass filter to filter the received, reflected distorted signal to remove therefrom the first order component thereof.	6. The ultrasonic diagnostic imaging system of Claim 5, wherein said filter comprises a programmable digital filter.

Acuson has a potential interest in acquiring rights in any patent maturing from the Christopher application and requests that the Examiner:

(1) review all pending claims to determine if an interference should be declared between the Christopher application and any pending U.S. patent application claiming priority to the Averkiou provisional application; and

(2) review the references cited on the enclosed PTO Form 1449, which lists the Averkiou EPO application, the Averkiou provisional application, the Averkiou dissertation, and the references filed with the Averkiou protest.

Additionally, Acuson hereby certifies that a duplicate copy of this Protest has been sent to Research Corporation Technologies, the owner of the Christopher application, by first class mail on October 22, 1998 at the following address:

Mr. Timothy Reckart, Esq.
General Counsel, Secretary and Director of Legal Affairs
Research Corporation Technologies
101 North Wilmot Road, Suite 500
Tucson, Arizona 85711-3335

Dated: October 22, 1998

Respectfully submitted,

ACUSON CORPORATION

Joseph F. Hetz
Registration No. 41,070

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312) 321-4200

"Express Mail" mailing label number: EL130693351US
Date of Deposit: October 22, 1998

FAXED COPY RECEIVED
OCT 26 1998
GROUP 3300

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Michalakis Averkiou Jeffry E. Powers Peter N. Burns David N. Roundhill Juin-Jet Hwang	Attn:	Office of Petitions Crystal Park 1, Room 520
Serial No:	Unknown	Filed:	Between November 26, 1996 and November 26, 1997
Priority:	U.S. Provisional Patent Application Serial No. 60/032,771; filed November 26, 1996	Related to:	European Patent Applicant EP 0 851 241 A2
For:	ULTRASONIC DIAGNOSTIC IMAGING OF RESPONSE FREQUENCY DIFFERING FROM TRANSMIT FREQUENCY	Assignee:	ATL Ultrasound, Inc. Bothell, Washington 98041

PROTEST UNDER 37 CFR § 1.291 (a)

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Acuson Corporation ("Acuson") respectfully requests that the materials enclosed herewith be considered during the examination of the above-identified patent application ("the Averkiou U.S. application"):

1. Abstract No. 1047 – "In Vivo Application of Contrast-enhanced Harmonic Imaging," Forsberg et al., Volume 189(P) Supplement to *Radiology* (November 1993) ("the Forsberg 1047 Abstract");

2. A copy of Acuson's Petition for the Institution of a Public Use Proceeding, filed herewith ("the Public Use Petition");

3. PCT Application No. WO 98/20361 ("the Christopher PCT application");

4. U.S. Patent No. 4,865,042 to Umemura et al. ("the Umemura '042 patent");

5. U.S. Patent No. 5,435,311 to Umemura et al. ("the Umemura '311 patent");

6. U.S. Patent No. 4,620,546 to Aida et al. ("the Aida patent");

7. "Simulated Capillary Blood Flow Measurement Using a Nonlinear Ultrasonic Contrast Agent," B. Schrope, V.L. Newhouse, and V. Uhlendorf (1992) ("the Uhlendorf article");

8. U.S. Patent No. 5,724,976 to Mine et al. ("the Mine patent");

9. Abstract No. 1046 – "Harmonic Contrast-enhanced Doppler as a Method for the Elimination of Clutter: In Vivo Duplex and Color Studies," Burns et al., Volume 189(P) Supplement to *Radiology* (November 1993) ("the Burns 1046 Abstract");

10. Excerpt from the Ultramark 9 Ultrasound System Operation Manual ("the UM9 Operation Manual"); and

11. European Patent Application EP 0 851 241 A2 ("the Averkiou EPO application").

I. DISCUSSION OF THE CITED REFERENCES

Acuson has not reviewed the claims in the Averkiou U.S. application and requests that all pending claims be examined in view of these references. To the extent that the pending claims in the Averkiou U.S. application are similar to the claims in the Averkiou EPO application, these references may, either alone or in combination, render one or more of the pending claims unpatentable. To facilitate review of these references, the following sections highlight passages that may be of particular relevance.

1. The Forsberg 1047 Abstract

The Forsberg 1047 Abstract teaches imaging a second harmonic response generated by tissue prior to injection of contrast agent:

> "Two dogs were examined before and after intravenous administration of [contrast agent]. Vascular structures . . . and visceral organs . . . were imaged with a modified [Acuson] 128XP US unit . . . . Harmonic imaging was achieved by transmitting a 2.5-MHz pulse and receiving backscattered signal at 5.0 MHz. . . . Prior to contrast agent administration, received signal from tissue was 10-20 dB lower in harmonic imaging mode."

2. The Public Use Petition

The Public Use Petition includes evidence that ultrasound images of heart tissue, acquired at the second harmonic of the fundamental transmission frequency in the absence of added contrast agent, were in public use in the United States in March of 1993, June of 1993, and September of 1994 – more than one year before the November 26, 1996 priority date of the Averkiou U.S. application. These images included tissue harmonic signal resulting from second harmonic distortion of the fundamental ultrasound beam as it propagated through the tissues of the animal subject.

3. The Christopher PCT Application

The Christopher PCT application claims priority to U.S. Patent Application Serial No. 08/746,360, filed November 8, 1996 ("the Christopher U.S. application"). Since the Christopher U.S. application was filed before Averkiou's November 26, 1996 provisional application, the Christopher U.S. application may be prior art under 35 U.S.C. §§ 102(e) and 102(g). Acuson has not reviewed the Christopher U.S. application; accordingly, the following excerpts are from the Christopher PCT application. The third, fourth, and fifth excerpts may be of particular relevance to claims corresponding to Claim 45 in the Averkiou EPO application, and the last excerpt may be of particular relevance to claims corresponding to Claims 35-38.

> "Figure 1 illustrates ultrasonic imaging system 10. A pulse generator 12 and a function generator 14 produce a sinusoidal pulse ultrasonic signal of, for example, 2.0 MHz at a pulse repeat frequency of, for instance, 1 kHz. This signal is sent to amplifier 20, which amplifies the signal and transmits the amplified signal to transducer-receiver unit 22, and this unit then transmits the signal into sample 24" (page 6, lines 7-15).

> In this sample 24, the input signal is both distorted and reflected. The distortion creates a distorted signal having a multitude of component signals, each of which has a respective frequency or frequency bandwidth. The distorted signal is reflected by sample 24, and this reflected signal is received by transducer-receiver unit 22, amplified by pre-amplifier 30, and then further amplified by amplifier 32. The received and amplified signal is then sent through a high-pass filter 34 to enhance the relative strength of the desired higher harmonic component of the received signal. The resulting signal is digitized in analog-to-digital converter 36, and then processed by processor 40 to produce an image" (page 6, lines 16-30).

> "In general, such an image can be formed by using a two pulse transmit, receive, normalize, and then high pass filtering scheme. Such a two pulse scheme can be used to remove the source or linear content in the second and higher harmonic bandwidths" (page 2, line 28 - page 3, line 2).

> "System 10 can also be operated in a two pulse scheme or mode. In this mode of operation, system 10 generates and transmits into sample 24 two different pulses. Preferably, the transmitted signals are identical except that one of them is scaled up in pressure. . . . The reflected, distorted signals from both pulses are received by transducer unit 22, and these signals are digitized in analog-to-digital converter 36. The digital data values

The Averkiou EPO Application	The Christopher PCT Application
11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:	1. A method of imaging a sample comprising the steps of:
transmitting ultrasonic energy into the body at a fundamental frequency;	generating an ultrasonic signal; directing the ultrasonic signal into a sample, wherein the sample reflects the signal;
receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
processing said harmonic echo signals to produce ultrasonic image display signals; and	forming an image from one of said higher order component signals of the received distorted signal, including the step of removing from the received distorted signal the first order component thereof; and
displaying said ultrasonic image display signals.	displaying said formed image.

4. The Umemura '042 Patent

The following excepts of the Umemura '042 patent may be of particular relevance:

"[B]y the nonlinear acoustic parameter A/B of a substance . . ., there are generated the harmonics components of the irradiating ultrasound waves . . . . [O]bserving the harmonics waves which are generated by the nonlinear acoustic effect" (col. 8, lines 3-19).

"Both the echo signals generated due to discontinuity of the acoustic impedance in the object and the harmonics signals generated due to the acoustical nonlinear effect by the irradiating ultrasound waves are received by the respective elements of the imaging auxiliary probe 6, amplified by the transmitting and receiving amplifiers 13, and focused by the receiving beam former 14. . . . These signals are fed through an imaging circuit 15 to a display unit 16 so that the generated positions and the ultrasound intensities of the echo signals or the harmonics signals are displayed through the imaging circuit 15 in the display frame of the display unit 16. The receiving beam former 14 is equipped with . . . a band-pass filter so that its center frequency is registered to the imaging ultrasound frequency, which is more than twice as high as the irradiating ultrasound frequency" (col. 6, line 55- col. 7, line 9).

"[T]he transducer 1 is divided into concentric ring-shaped transducer elements . . . . [The] auxiliary probe 6 is of a small linear (or convex) array type, in which the transducer elements have a resonance frequency between 100 KHz and 10 MHz, which is selected to be two or more times as high as the resonance frequency of the transducer 1. In a suitable example, the transducer 1 has a resonance frequency of 500 kHz whereas the auxiliary probe 6 has a resonance frequency of 3 MHz" (col. 3, lines 15-35).

5. The Umemura '311 Patent

The following excepts of the Umemura '311 patent may be of particular relevance:

"[I]n the neighborhood of the focal point of the focused ultrasound[,] harmonics[,] and in particular even order harmonics[,] are produced by nonlinear effects. This harmonic signal passes through the same path and it is subjected to the same processing as the ultrasonic pulse echo signal. Then it is displayed, superimposed on the pulse echographic image" (col. 4, lines 39-45).

"[A] part of energy of the pulse-shaped ultrasound, which has been focused to have a high intensity, is converted into harmonics in the same frequency band as the imaging ultrasound by a non-linear phenomenon" (col. 8, lines 27-31).

"A focused ultrasound generating transmitter . . . consists of . . . a number of piezoelectric elements 2 made of piezoelectric ceramics (these are so selected that the resonance frequency is 750 kHz)" (col. 3, lines 10-16).

"Each of the monitoring ultrasound transmitters/receivers is composed of an array-shaped ultrasound transducer consisting of e.g. 100 piezoelectric elements" (col. 3, lines 31-34).

"The monitoring ultrasound transmitter/receiver is so constructed that not only it receives echo of pulsed ultrasound transmitted by itself, but also it can receive even order harmonic wave signals" (col. 1, line 66 - col. 2, line 3).

6. The Aida Patent

The following excepts of the Aida patent may be of particular relevance:

"Generally, when ultrasound propagates in a medium (e.g., tissue), the waveform of the ultrasound is distorted as the sound pressure thereof increases. . . . In other words, harmonic components are formed by waveform [non-linear] distortion" (col. 5, lines 20-37).

"In order to detect the focusing point of the ultrasound from the applicator 4, a reception signal received by the probe 3 is supplied to a harmonic wave detector 38. The harmonic wave detector may be comprised of a band-pass filter, which extracts from the output signal of the probe 3 harmonic components of ultrasound radiated by the applicator 4, thus detecting the hot spot. . . . [A] reception frequency band of the probe 3 can cover the harmonics of the heating ultrasound frequency" (col. 5, lines 7-19).

"The probe 3 performs sector electronic scanning by means of a B mode system 5 so as to obtain tomographic image information of the living organism. . . . When the probe 3 comprises array transducers, the B mode system 5 comprises a scanning circuit which performs focusing and deflection of a 3.5-MHz ultrasound beam by driving each transducer through a delay circuit" (col. 2, lines 23-31).

"The heating applicator 4 is driven by a driver 7 to continuously radiate a focused ultrasound beam having a relatively high energy and frequency of, e.g., 500 kHz to 1 MHz" (col. 2, lines 37-40).

"[H]armonic components can be detected utilizing the filter function of the probe 3" (col. 5, lines 63-65).

7. The Uhlendorf Article

As shown in Table I on page 148 and in the following passages, the Uhlendorf article teaches that a second harmonic response can be generated by tissue:

"It must be emphasized that the nonlinear propagation of an acoustic wave through a material is not the same phenomenon as the nonlinearity generated by bubbles in an acoustic field. Nonlinear propagation of an acoustic wave is due to the fact that the velocity of propagation of a finite-amplitude sound wave varies with pressure. As the pressure increases, the velocity of the sinusoidal wave is greater at the pressure maximum than it is at the pressure minimum. This leads to a continuous distortion of the wave, resulting in the generation of harmonics of the source frequency in the medium. This nonlinearity may be characterized by the dimensionless B/A parameter, which relates the pressure amplitude of the fundamental frequency with the pressure amplitude of the second harmonic frequency. For liquids such as water and for many biological tissues, B/A ranges from 5.5 to 11. For bubbly media, however, values of B/A on the order of 10^4 or 10^5 have been reported [7]. Thus, we can expect a much more strongly nonlinear scattered wave from bubbly suspensions (such as contrast agents containing "free" air bubbles) than from either the water medium by itself or from biological tissue" (page 137, last paragraph).

"Using a nonlinear contrast agent and analyzing the second harmonic component of the echo, however, would greatly improve the signal-to-clutter ratio and differentiate blood flow echoes from tissue motion echoes. Analysis to follow shows that the nonlinearity produced by propagation through the tissue is negligible compared to that produced by the contrast agent in the capillaries; thus, echoes from surrounding tissue clutter and vasomotion are virtually eliminated" (page 138-139).

"It is evident then that our presumption that the contrast agent has stronger scattering than tissue at the nonlinear second harmonic is verified" (page 145, last paragraph).

"In addition, the acoustic properties of the tissue must be modeled. These properties are, of course, scattering and attenuation, and, due to the special circumstances in this measurement, tissue nonlinearity (B/A). . . . To estimate the nonlinear response from tissue, we use Eq. (4) and assume a typical value of B/A for a soft tissue such as muscle of 7.2 [13]; hence, under the experimental circumstances given above, the second harmonic component, σ_{t2}, is found to be 2×10^{-5} m^{-3}" (page 146-47).

"We must also recognize that the tissue itself will generate some harmonic distortion on both transmit and receive" (page 148, second full paragraph).

"For the same muscle tissue, we would expect some conversion of the fundamental frequency to the second harmonic via nonlinear propagation through the tissue. . . . This corresponds to a scattering cross section of $\sigma_{t2}=3.59\times10^{-4}$ m^{-3}, still quite significantly less than that of the contrast agent, $\beta\sigma_{c2}=0.0227$ m^{-3} (see table 1 for comparison of all calculated values). The results of this analysis are encouraging for further study into the problem. The amplitude of the second harmonic component of the backscattered signal, even from very small relative volumes, is powerful enough (i.e., much stronger than the tissue echo) to be recognized as signal from contrast agent" (page 149, second and third full paragraphs).

8. The Mine Patent

As shown by the following excerpts, the Mine patent teaches transmitting ultrasonic energy into the body at a fundamental frequency, receiving ultrasonic echo signals at a harmonic of the fundamental frequency, and processing the harmonic echo signals to produce and display ultrasonic image display signals.

"A diagnostic ultrasound system of the first embodiment implements contrast echography to efficiently detect a second harmonic that is a non-fundamental component produced due to nonlinear scattering caused by a foam contained in an ultrasound contrast medium, and then two-dimensionally display a second-harmonic distribution image" (col. 6, lines 36-43).

"The transmission system . . . generates . . . driving pulses" (col. 9, lines 21-33).

"[U]ltrasound beams each having the fundamental component f alone are irradiated to a desired diagnostic region of a subject" (col. 10, lines 31-33).

"Since an ultrasound contrast medium is flowing into or out from the diagnostic region by means of blood, each of echoes [sic] consists mainly of scattered components induced by a tissue and the ultrasound contrast medium; that is, nonlinear scattered components including a second harmonic induced by the contrast medium are included in each echo" (col. 10, lines 33-39).

"The second harmonic 2f alone of each echo is extracted by the HPF [high-pass filter] circuit . . . . This results in a contrast-mode B-mode image signal deriving from the second harmonic stemming from nonlinear scattering caused by a contrast medium" (col. 10, lines 57-61).

"The image signal is displayed" (col. 10, lines 61-62).

9 and 10. The Burns 1046 Abstract and the UM9 Operation Manual

The Burns 1046 Abstract and the UM9 Operation Manual may be of particular relevance to claims that recite a programmable digital filter, such as claims that correspond to Claims 6 and 42 in the Averkiou EPO application. The Burns 1046 Abstract states:

"Real-time duplex and color Doppler was performed with transmit and receive frequencies of 3.75-4.5 MHz and 7.5-9 MHz, respectively, by using a programmable digital US system (UM9 HDI, ATL), so that only Doppler shifts of the second harmonic were detected. Wall filters were set at minimum."

The UM9 Operation Manual provides further information about the UM9 programmable digital ultrasound system described in the Burns 1046 Abstract. On page S-3 under the heading "Digital Signal Processing," the manual describes: "Software controlled selection of bandwidth, filters and frequencies." Acuson submits that the UM9 ultrasound system has a programmable digital filter: the listing of "filter" under the heading Digital Signal Processing teaches that the filter is digital, and the description "software controlled selection" teaches that the digital filter is programmable.

II. CONCLUSION

Acuson has not reviewed the claims of the Averkiou U.S. application and requests that the Examiner compare all pending claims with the references described above. To the extent that

the claims in the Averkiou U.S. application are similar to the claims in the Averkiou EPO application, these references, either alone or in combination, may render one or more of the pending claims unpatentable. For example, Claim 11 in the Averkiou EPO application recites transmitting, receiving, processing, and displaying steps that read on the Forsberg 1047 Abstract, the public uses described in the Public Use Petition, the Christopher PCT application, and the Umemura '042, Umemura '311, and Mine patents. Further, Acuson requests that all pending claims in the Averkiou U.S. application and the Christopher U.S. application be examined to determine if an interference should be declared.

Additionally, Acuson hereby certifies that a duplicate copy of this Protest has been sent to Advanced Technology Laboratories, Inc., the agent of record named in the provisional application and the assignee named in the Averkiou EPO application, by first class mail on October 22, 1998 at the following address:

Mr. W. Brinton Yorks, Jr.
Advanced Technology Laboratories, Inc.
22100 Bothell Everett Highway
Bothell, Washington 98041-3003

Dated: October 22, 1998

Respectfully submitted,

ACUSON CORPORATION

Joseph F. Hetz
Registration No. 41,070

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312) 321-4200

The Averkiou EPO Application	The Christopher PCT Application
1. An ultrasonic diagnostic imaging system for imaging the harmonic response of structure inside a body, comprising:	9. A system for imaging a sample, comprising:
means for transmitting ultrasonic energy into the body at a fundamental frequency;	means for generating an ultrasonic signal; means for directing the ultrasonic signal into a sample, wherein the sample reflects the signal;
means, responsive to said transmitted ultrasonic energy, for receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	means for receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
means for producing an ultrasonic image from said harmonic echo signals.	means for forming an image from one of said higher order component signals of the received distorted signal, said means for forming the image including means for removing from the received distorted signal the first order component thereof; and means for displaying said formed image.
1. An ultrasonic diagnostic imaging system for imaging the harmonic response of structure inside a body, comprising:	15. A system for imaging a sample, comprising:
means for transmitting ultrasonic energy into the body at a fundamental frequency;	means for generating an ultrasonic signal; means for directing the ultrasonic signal into a sample, wherein the sample reflects the signal;
means, responsive to said transmitted ultrasonic energy, for receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	means for receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
means for producing an ultrasonic image from said harmonic echo signals.	means for forming an image from one of said higher order component signals of the received distorted signal; wherein said higher order component signals include a second order component, and the means for forming the image includes means for forming the image from said second order component; and means for displaying said formed image.
1. An ultrasonic diagnostic imaging system for imaging the harmonic response of structure inside a body, comprising:	19. A system for imaging a sample, comprising:
means for transmitting ultrasonic energy into the body at a fundamental frequency;	means for generating a series of ultrasonic pulse signals; means for directing the ultrasonic pulse signals into a sample, wherein the sample reflects the pulse signals;

means, responsive to said transmitted ultrasonic energy, for receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	means for receiving the pulse signals reflected by said sample, which received pulse signals are distorted and contain a first order and higher order component signals at first and higher frequencies respectively;
means for producing an ultrasonic image from said harmonic echo signals.	means for forming an image from one of said higher order component signals of the received distorted pulse signals; and means for displaying said formed image.
1. An ultrasonic diagnostic imaging system for imaging the harmonic response of structure inside a body, comprising:	20. A system for imaging a sample, comprising:
means for transmitting ultrasonic energy into the body at a fundamental frequency;	means for generating an ultrasonic signal; means for directing the ultrasonic signal into a sample, wherein the sample reflects the signal;
means, responsive to said transmitted ultrasonic energy, for receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	means for receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
means for producing an ultrasonic image from said harmonic echo signals.	means for forming an image from one of said higher order component signals of the received distorted signal; and means for displaying said formed image; wherein the sample is a biological sample.
1. An ultrasonic diagnostic imaging system for imaging the harmonic response of structure inside a body, comprising:	22. A system for imaging a sample, comprising:
means for transmitting ultrasonic energy into the body at a fundamental frequency;	means for generating an ultrasonic signal; means for directing the ultrasonic signal into a sample, wherein the sample linearly reflects the signal;
means, responsive to said transmitted ultrasonic energy, for receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	means for receiving the signal linearly reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
means for producing an ultrasonic image from said harmonic echo signals.	means for forming an image from one of said higher order component signals of the received linearly reflected, distorted signal; and means for displaying said formed image.

5. The ultrasonic diagnostic imaging system of Claim 1, wherein said means for receiving ultrasonic echo signals at a harmonic of said fundamental frequency comprises a filter defining a passband which includes said harmonic frequency to the exclusion of said fundamental frequency.	10. A system according to Claim 9, wherein the means for removing the first order component from the received distorted signal includes a high-pass filter to filter the received, reflected distorted signal to remove therefrom the first order component thereof.
6. The ultrasonic diagnostic imaging system of Claim 5, wherein said filter comprises a programmable digital filter.	10. A system according to Claim 9, wherein the means for removing the first order component from the received distorted signal includes a high-pass filter to filter the received, reflected distorted signal to remove therefrom the first order component thereof.
9. The ultrasonic diagnostic imaging system of Claim 1, wherein said structure comprises naturally occurring structure of the body.	Claim 22 ("wherein the sample linearly reflects the signal")
10. The ultrasonic diagnostic imaging system of Claim 9, wherein said naturally occurring structure comprises tissue and cells of the body.	Claim 22 ("wherein the sample linearly reflects the signal")
11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:	1. A method of imaging a sample comprising the steps of:
transmitting ultrasonic energy into the body at a fundamental frequency;	generating an ultrasonic signal; directing the ultrasonic signal into a sample, wherein the sample reflects the signal;
receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
processing said harmonic echo signals to produce ultrasonic image display signals; and	forming an image from one of said higher order component signals of the received distorted signal, including the step of removing from the received distorted signal the first order component thereof; and
displaying said ultrasonic image display signals.	displaying said formed image.
11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:	7. A method of imaging a sample, comprising the steps of:

transmitting ultrasonic energy into the body at a fundamental frequency;

receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and

processing said harmonic echo signals to produce ultrasonic image display signals; and

displaying said ultrasonic image display signals.

11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:

transmitting ultrasonic energy into the body at a fundamental frequency;

receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and

processing said harmonic echo signals to produce ultrasonic image display signals; and

displaying said ultrasonic image display signals.

11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:

transmitting ultrasonic energy into the body at a fundamental frequency;

receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and

processing said harmonic echo signals to produce ultrasonic image display signals; and

generating an ultrasonic signal:
directing the ultrasonic signal into a sample, wherein the sample reflects the signal;

receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;

forming an image from one of said higher order component signals of the received distorted signal; and

displaying said formed image;
wherein said higher order component signals include a second order component, and the forming step includes the step of forming the image from said second order component.

17. A method of imaging a sample, comprising the steps of:

generating a series of ultrasonic pulse signals;
directing the ultrasonic pulse signals into a sample, wherein the sample reflects the pulse signals;

receiving the pulse signals reflected by said sample, which received pulse signals are distorted and contain a first order and higher order component signals at first and higher frequencies respectively;

forming an image from one of said higher order component signals of the received distorted pulse signals; and

displaying said formed image.

18. A method of imaging a biological sample, comprising the steps of:

generating an ultrasonic signal;
directing the ultrasonic signal into the biological sample, wherein the sample reflects the signal;

receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;

forming an image from one of said higher order component signals of the received distorted signal; and

displaying said ultrasonic image display signals.	displaying said formed image.
11. A method for producing an ultrasonic image from the harmonic response of the interior of the body comprising the steps of:	21. A method of imaging a sample, comprising the steps of:
transmitting ultrasonic energy into the body at a fundamental frequency;	generating an ultrasonic signal; directing the ultrasonic signal into the biological sample, wherein the sample linearly reflects the signal;
receiving ultrasonic echo signals at a harmonic of said fundamental frequency; and	receiving the signal linearly reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;
processing said harmonic echo signals to produce ultrasonic image display signals; and	forming an image from one of said higher order component signals of the received distorted signal; and
displaying said ultrasonic image display signals.	displaying said formed image.
14. The method of Claim 11, wherein the step of receiving ultrasonic echo signals at a harmonic of said fundamental frequency comprises passing received ultrasonic echo signals through a filter which passes signals at said harmonic of said fundamental frequency to the exclusion of said fundamental frequency.	2. A method according to Claim 1, wherein the removing step includes the step of high-pass filtering the received, reflected distorted signal to remove therefrom the first order component thereof.
Claims 35-38	Claims 11-14
Claims 39-42	Claims 9, 10, 15, 19, 20, and 22
43. An ultrasonic diagnostic imaging system for imaging the nonlinear response of tissue, comprising:	9. A system for imaging a sample, comprising:
a transmitter for transmitting ultrasonic energy into the body at a fundamental frequency;	means for generating an ultrasonic signal; means for directing the ultrasonic signal into a sample, wherein the sample reflects the signal;
a receiver, responsive to echoes returned from tissue following said ultrasonic energy transmission, for separating signals representing the nonlinear response of tissue to ultrasound; and	means for receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;

an image processor for producing an ultrasonic image from said nonlinear response signals.

means for forming an image from one of said higher order component signals of the received distorted signal, said means for forming the image including means for removing from the received distorted signal the first order component thereof; and
means for displaying said formed image.

43. An ultrasonic diagnostic imaging system for imaging the nonlinear response of tissue, comprising:

a transmitter for transmitting ultrasonic energy into the body at a fundamental frequency;

a receiver, responsive to echoes returned from tissue following said ultrasonic energy transmission, for separating signals representing the nonlinear response of tissue to ultrasound; and

an image processor for producing an ultrasonic image from said nonlinear response signals.

15. A system for imaging a sample, comprising:

means for generating an ultrasonic signal;
means for directing the ultrasonic signal into a sample, wherein the sample reflects the signal;

means for receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;

means for forming an image from one of said higher order component signals of the received distorted signal; wherein said higher order component signals include a second order component, and the means for forming the image includes means for forming the image from said second order component; and
means for displaying said formed image.

43. An ultrasonic diagnostic imaging system for imaging the nonlinear response of tissue, comprising:

a transmitter for transmitting ultrasonic energy into the body at a fundamental frequency;

a receiver, responsive to echoes returned from tissue following said ultrasonic energy transmission, for separating signals representing the nonlinear response of tissue to ultrasound; and

an image processor for producing an ultrasonic image from said nonlinear response signals.

19. A system for imaging a sample, comprising:

means for generating a series of ultrasonic pulse signals;
means for directing the ultrasonic pulse signals into a sample, wherein the sample reflects the pulse signals;

means for receiving the pulse signals reflected by said sample, which received pulse signals are distorted and contain a first order and higher order component signals at first and higher frequencies respectively;

means for forming an image from one of said higher order component signals of the received distorted pulse signals; and
means for displaying said formed image.

43. An ultrasonic diagnostic imaging system for imaging the nonlinear response of tissue, comprising:

a transmitter for transmitting ultrasonic energy into the body at a fundamental frequency;

20. A system for imaging a sample, comprising:

means for generating an ultrasonic signal;
means for directing the ultrasonic signal into a

a receiver, responsive to echoes returned from tissue following said ultrasonic energy transmission, for separating signals representing the nonlinear response of tissue to ultrasound; and

an image processor for producing an ultrasonic image from said nonlinear response signals.

43. An ultrasonic diagnostic imaging system for imaging the nonlinear response of tissue, comprising:

a transmitter for transmitting ultrasonic energy into the body at a fundamental frequency;

a receiver, responsive to echoes returned from tissue following said ultrasonic energy transmission, for separating signals representing the nonlinear response of tissue to ultrasound; and

an image processor for producing an ultrasonic image from said nonlinear response signals.

44. The ultrasonic diagnostic imaging system of Claim 43, wherein said receiver includes a filter circuit for separating signals representing the nonlinear response of tissue to ultrasound.

Claim 45

Claim 46

sample, wherein the sample reflects the signal;

means for receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;

means for forming an image from one of said higher order component signals of the received distorted signal; and

means for displaying said formed image;

wherein the sample is a biological sample.

22. A system for imaging a sample, comprising:

means for generating an ultrasonic signal;

means for directing the ultrasonic signal into a sample, wherein the sample linearly reflects the signal;

means for receiving the signal linearly reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;

means for forming an image from one of said higher order component signals of the received linearly reflected, distorted signal; and

means for displaying said formed image.

10. A system according to Claim 9, wherein the means for removing the first order component from the received distorted signal includes a high-pass filter to filter the received, reflected distorted signal to remove therefrom the first order component thereof.

Claim 19

Claims 9, 15, 19, 20, and 22

FACSIMILE COVER SHEET

FAXED COPY RECEIVED
OCT 26 1998
GROUP 3300

BRINKS
HOFER
GILSON
&LIONE

A Professional Corporation
Intellectual Property Attorneys

NBC Tower - Suite 3600
455 N. Cityfront Plaza Drive
Chicago, Illinois 60611-5599
Facsimile 312-321-4299
Telephone 312-321-4200

Indianapolis, IN
Detroit, MI
Toledo, OH
Arlington, VA

Date: October 26, 1998

To: Examiner F. Jaworski
Fax No: (703) 305-3579

From: Joe Hetz
Tel. No: (312) 321-4719

Client No: 5050

No. of Pages
(inc. this page): 20

Confirmation Copy To Follow: Yes ___ No _X_

IF YOU HAVE ANY PROBLEMS RECEIVING THIS MESSAGE,
PLEASE CALL 312-321-4200 AND ASK FOR: Joe Hetz

COVER MESSAGE:

Enclosed are courtesy copies of the Second Protest to the Christopher application and the Protest to the Averkiou application, both of which were filed on October 22, 1998.

FAXED COPY RECEIVED
AUG 14 1998
GROUP 3300

BRINKS
HOFER
GILSON
&LIONE

A Professional Corporation
Intellectual Property Attorneys

NBC Tower - Suite 3600
455 N. Cityfront Plaza Drive
Chicago, Illinois 60611-5599
Facsimile 312-321-4299
Telephone 312-321-4200

Indianapolis, IN
Detroit, MI
Toledo, OH
Arlington, VA

FACSIMILE COVER SHEET

Date: August 13, 1998

To: Examiner F. Jaworski
Fax No: (703) 305-3579

From: Joe Hetz
Tel. No: (312) 321-4719

Client No: 5050

No. of Pages
(inc. this page): 7

Confirmation Copy To Follow: Yes ___ No _X_

IF YOU HAVE ANY PROBLEMS RECEIVING THIS MESSAGE,
PLEASE CALL 312-321-4200 AND ASK FOR: Joe Hetz

COVER MESSAGE:

FAXED COPY RECEIVED
AUG 14 1998
GROUP 3300

COURTESY COPY

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on August 13, 1998
Date of Deposit

Joseph F. Hetz - Reg. No. 41,070
Name of Applicant, Assignee or Registered Representative

Signature

Original to Mail

Our Case No. 5050/296 # 18 8/17

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Ted Christopher	Examiner: F. Jaworski
Serial No.:	08/746,360	Group Art Unit: 3700
Filed:	November 8, 1996	
For:	Finite Amplitude Distortion-Based Inhomogeneous Pulse Echo Ultrasonic Imaging	

AS FILED

Assistant Commissioner for Patents
Washington, D.C. 20231

ATTENTION: DIRECTOR OF GROUP 3700

PROTEST UNDER 37 CFR 1.291 (a)

Sir:

Enclosed is a copy of an article by B. Schrope, V.L. Newhouse, and V. Uhlendorf entitled "Simulated Capillary Blood Flow Measurement Using a Nonlinear Ultrasonic Contrast Agent" ("the Uhlendorf article") and a copy of U.S. Patent No. 5,724,976 to Mine et al. ("the Mine patent"). Also enclosed is published PCT application number WO 98/20361 ("the PCT application"), which claims priority to the above-identified patent application ("the Christopher application"). Protestor requests that the Uhlendorf article and the Mine patent be reviewed during the examination of the Christopher application.

This Protest contains two sections. The first section highlights portions of the Uhlendorf article that may be relevant to the claims in the Christopher application that are similar to any of Claims 8, 16, and 21-22 in the PCT application. The second section compares the remaining claims in the PCT application with selected portions of the Mine patent.

I. The Uhlendorf Article

Protestor requests that the claims in the Christopher application, particularly those that are similar to any of Claims 8, 16, and 21-22 in the PCT application, be examined in view of the Uhlendorf article. As shown in Table I on page 148 and in the following passages, the Uhlendorf article teaches that a second harmonic response can be generated by tissue:

"It must be emphasized that the nonlinear propagation of an acoustic wave through a material is not the same phenomenon as the nonlinearity generated by bubbles in an acoustic field. Nonlinear propagation of an acoustic wave is due to the fact that the velocity of propagation of a finite-amplitude sound wave varies with pressure. As the pressure increases, the velocity of the sinusoidal wave is greater at the pressure maximum than it is at the pressure minimum. This leads to a continuous distortion of the wave, resulting in the generation of harmonics of the source frequency in the medium. This nonlinearity may be characterized by the dimensionless B/A parameter, which relates the pressure amplitude of the fundamental frequency with the pressure amplitude of the second harmonic frequency. For liquids such as water and for many biological tissues, B/A ranges from 5.5 to 11. For bubbly media, however, values of B/A on the order of 10^4 or 10^5 have been reported [7]. Thus, we can expect a much more strongly nonlinear scattered wave from bubbly suspensions (such as contrast agents containing "free" air bubbles) than from either the water medium by itself or from biological tissue" (page 137, last paragraph).

"Using a nonlinear contrast agent and analyzing the second harmonic component of the echo, however, would greatly improve the signal-to-clutter ratio and differentiate blood flow echoes from tissue motion echoes. Analysis to follow shows that the nonlinearity produced by propagation through the tissue is negligible compared to that produced by the contrast agent in the capillaries; thus, echoes from surrounding tissue clutter and vasomotion are virtually eliminated" (page 138-139).

"It is evident then that our presumption that the contrast agent has stronger scattering than tissue at the nonlinear second harmonic is verified" (page 145, last paragraph).

"In addition, the acoustic properties of the tissue must be modeled. These properties are, of course, scattering and attenuation, and, due to the special circumstances in this measurement, tissue nonlinearity (B/A). . . . To estimate the nonlinear response from tissue, we use Eq. (4) and assume a typical value of B/A for a soft tissue such as muscle of 7.2 [13]; hence, under the experimental circumstances given above, the second harmonic component, σ_{t2}, is found to be $2x10^{-5}$ m^{-3}" (page 146-47).

"We must also recognize that the tissue itself will generate some harmonic distortion on both transmit and receive" (page 148, second full paragraph).

"For the same muscle tissue, we would expect some conversion of the fundamental frequency to the second harmonic via nonlinear propagation through the tissue. . . . This corresponds to a scattering cross section of σ_{t2}=$3.59x10^{-4}$ m^{-3}, still quite significantly less than that of the contrast agent, $\beta\sigma_{c2}$=0.0227 m^{-3} (see table 1 for comparison of all calculated values). The results of this analysis are encouraging for further study into the

problem. The amplitude of the second harmonic component of the backscattered signal, even from very small relative volumes, is powerful enough (i.e., much stronger than the tissue echo) to be recognized as signal from contrast agent" (page 149, second and third full paragraphs).

Protestor further requests that the Uhlendorf article be considered along with the material presented in Protestor's Petition for the Institution of a Public Use Proceeding, filed March 20, 1998 ("the Public Use Petition"). The Public Use Petition includes evidence that ultrasound images of heart tissue, acquired at the second harmonic of the fundamental transmission frequency in the absence of added contrast agent, were in public use in the United States in March of 1993, June of 1993, and September of 1994. These images included tissue harmonic signal resulting from second harmonic distortion of the fundamental ultrasound beam as it propagated through the tissues of the animal subject.

II. The Mine Patent

Because the Mine patent describes several embodiments, Protestor provides the following comparison of the claims in the PCT application with selected portions of the Mine patent. To the extent that the claims in the PCT application are similar to the claims in the Christopher application, this comparison may facilitate the review of the Mine patent.

A. Claims 1-6 and Claims 9-14

1. Claims 1-2 and Claims 9-10

The PCT Application	The Mine Patent
1. A method of imaging a sample comprising the steps of:	"A diagnostic ultrasound system of the first embodiment implements contrast echography to efficiently detect a second harmonic that is a non-fundamental component produced due to nonlinear scattering caused by a foam contained in an ultrasound contrast medium, and then two-dimensionally display a second-harmonic distribution image" (col. 6, lines 36-43).
generating an ultrasonic signal;	"The transmission system . . . generates . . . driving pulses" (col. 9, lines 21-33).
directing the ultrasonic signal into a sample,	"[U]ltrasound beams each having the fundamental component f alone are irradiated to a desired diagnostic region of a subject" (col. 10, lines 31-33).

wherein the sample reflects the signal;	"[E]ach of echoes [sic] consists mainly of scattered components induced by a tissue and the ultrasound contrast medium" (col. 10, lines 35-37).
receiving the signal reflected by said sample, which received signal is distorted and contains a first order and higher order component signals at first and higher frequencies respectively;	"Since an ultrasound contrast medium is flowing into or out from the diagnostic region by means of blood, each of echoes [sic] consists mainly of scattered components induced by a tissue and the ultrasound contrast medium; that is, nonlinear scattered components including a second harmonic induced by the contrast medium are included in each echo (col. 10, lines 33-39).
forming an image from one of said higher order component signals of the received distorted signal, including the step of removing from the received distorted signal the first order component thereof; and	"The second harmonic 2f alone of each echo is extracted by the HPF [high-pass filter] circuit .... This results in a contrast-mode B-mode image signal deriving from the second harmonic stemming from nonlinear scattering caused by a contrast medium" (col. 10, lines 57-61).
displaying said formed image.	"The image signal is displayed" (col. 10, lines 61-62).
2. A method according to Claim 1, wherein the removing step includes the step of high-pass filtering the received, reflected distorted signal to remove therefrom the first order component thereof.	"The second harmonic 2f alone of each echo is extracted by the HPF [high-pass filter] circuit .... This results in a contrast-mode B-mode image signal deriving from the second harmonic stemming from nonlinear scattering caused by a contrast medium" (col. 10, lines 57-61).

Claims 9-10 are system claims that recite elements similar to those of Claims 1-2 in a different form.

2. Claims 3-6 and 11-14

Protestor requests that Claims 3-6 and 11-14 be examined in view of the above chart and in view of U.S. Patent No. 5,577,505 to Brock-Fisher et al. As the Examiner may be aware, Brock-Fisher et al. has been cited as a Category X reference in the PCT application. As stated in the Summary of the Invention, Brock-Fisher et al. discloses measuring an ultrasound response under multiple excitation levels. The responses gathered are gain corrected in an amount corresponding to the difference in excitation levels and then subtracted to remove most of the linear response.

B. Claims 7 and 15

Protester requests that Claims 7 and 15 be examined in view of the above chart and notes that the Mine patent states that the "nonlinear scattered components including a second harmonic

induced by the contrast medium are included in each echo" (col. 10, lines 37-39) and that the "image signal [deriving from the second harmonic] is displayed" (col. 10, lines 61-62).

C. Claims 17 and 19

Protester requests that Claims 17 and 19 be examined in view of the above chart and notes that the statements quoted from the Mine patent are in the context of a series of ultrasonic pulse signals.

D. Claims 18 and 20

Protester requests that Claims 18 and 20 be examined in view of the above chart and notes that the method and system described in the Mine patent are directed to imaging a blood-perfused region in the cardiac muscle (col. 10, lines 63-65).

III. Conclusion

Protestor requests that this Protest and the enclosed references be considered during the examination of the Christopher application. Protestor has a potential interest in acquiring rights in any patent maturing from the Christopher application and wishes to have this Protest considered carefully by the Patent Office.

Additionally, Protestor hereby certifies that a duplicate copy of this Protest has been sent to Research Corporation Technologies, the owner of the Christopher application, by first class mail on August 13, 1998 at the following address:

Mr. Timothy Reckart, Esq.
General Counsel, Secretary and Director of Legal Affairs
Research Corporation Technologies
101 North Wilmot Road, Suite 500
Tucson, Arizona 85711-3335

Dated: August 13, 1998

Respectfully submitted,

ACUSON CORPORATION

Joseph F. Hetz
Registration No. 41,070

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312) 321-4200